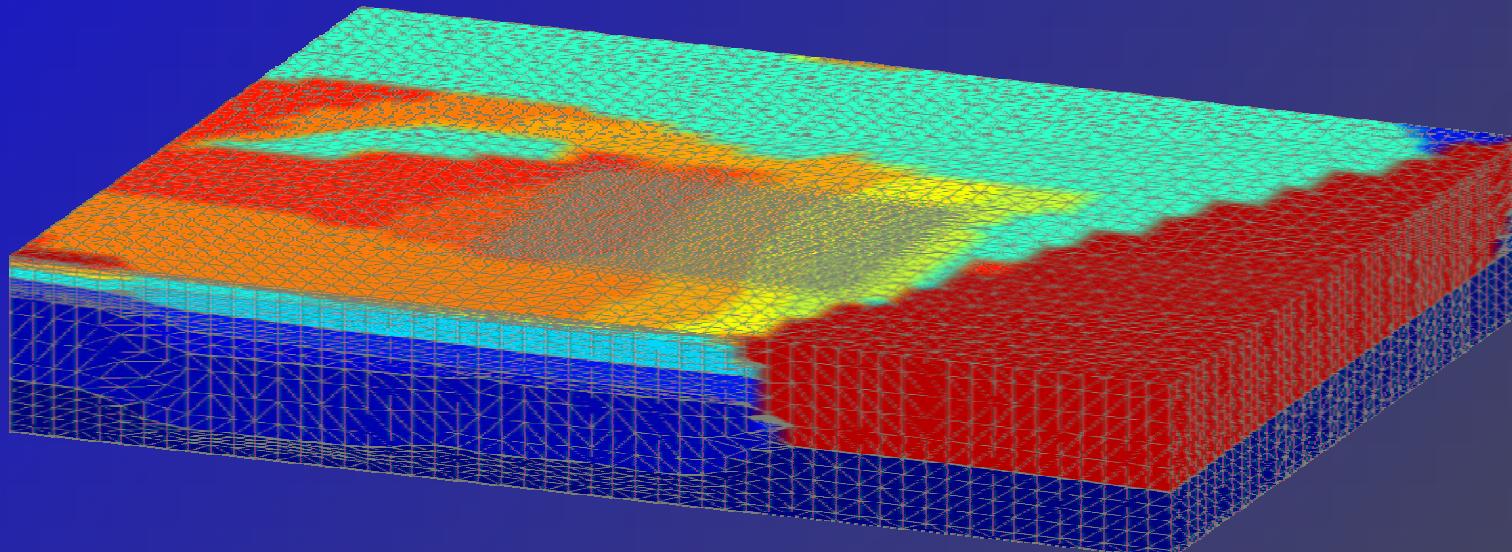


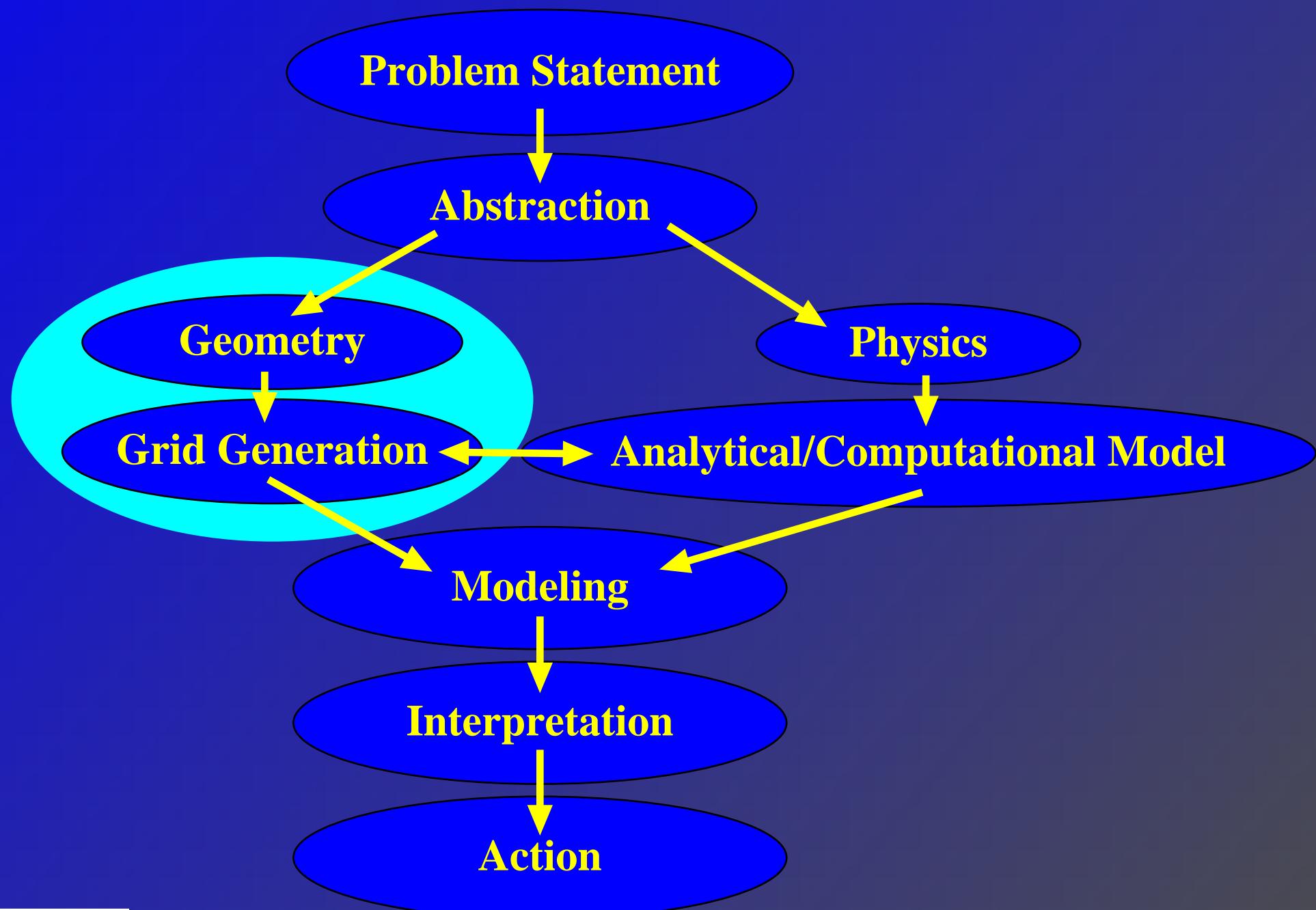
# Mesh Generation For Geological Applications

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# Modeling and Geometry



# Grid Generation $\longleftrightarrow$ Computational Model

## Finite Difference

- Orthogonal
- Non-orthogonal
- Constant vs. variable grid spacing

## Finite Element

- tri, quad, hex, tet, prism, pyramid
- hybrid

## – Finite Volume

- Regular (finite difference like)
- Arbitrary
  - > Voronoi
  - > Median mesh
  - > Polyhedra

## Non-Simplex

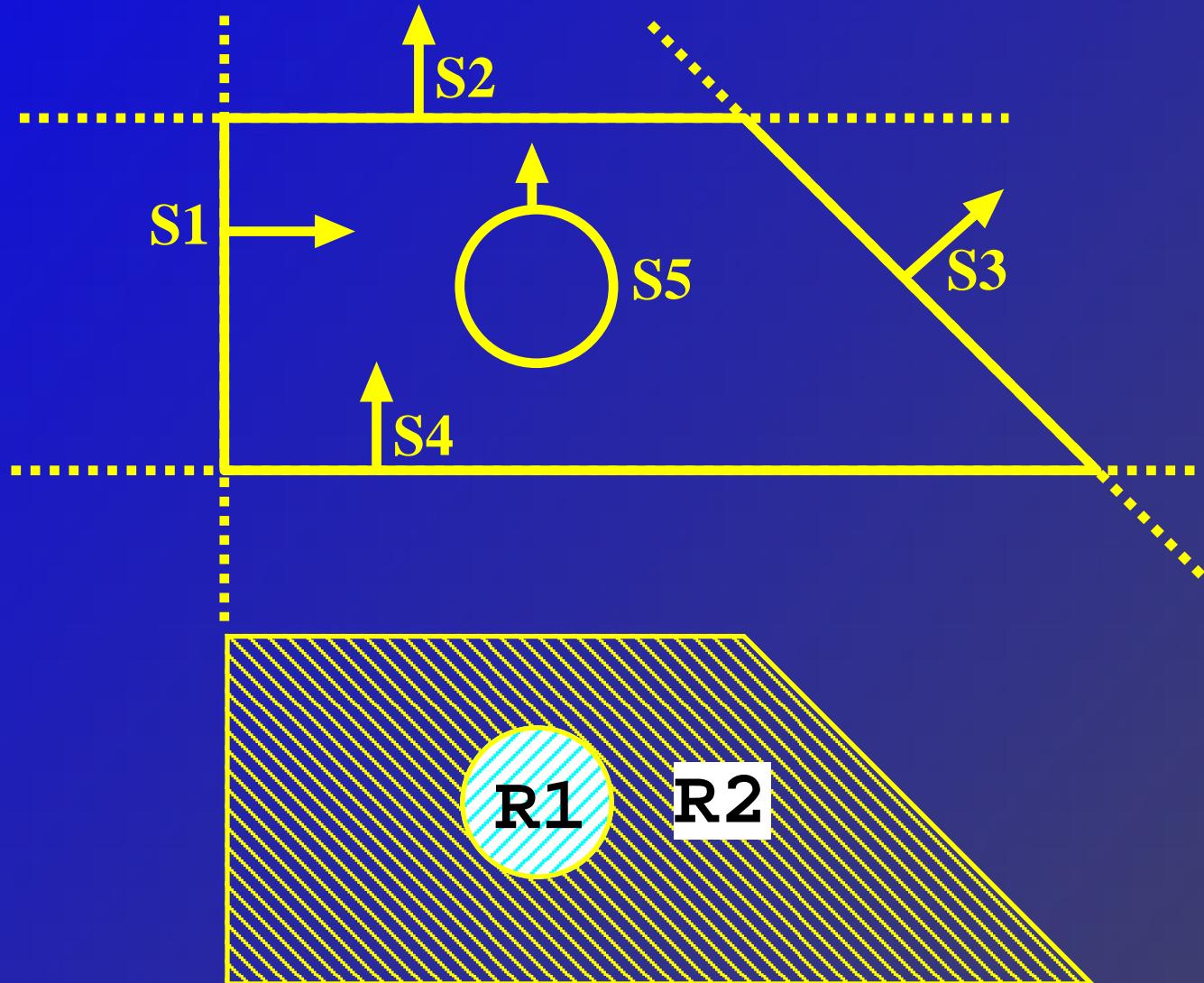
- Quadtree
- Octree

# Geometry/Topology Definition

## Constructive Solid Geometry

- Volumes bounded by surfaces
  - >Analytic Surfaces (cone, sphere, plane, etc)
  - >Splines, NURBS
  - >Tessellations (triangle surface)
- Cellular/Grid Volumes
- CAD Definition

# Boolean Operators For Region Definition

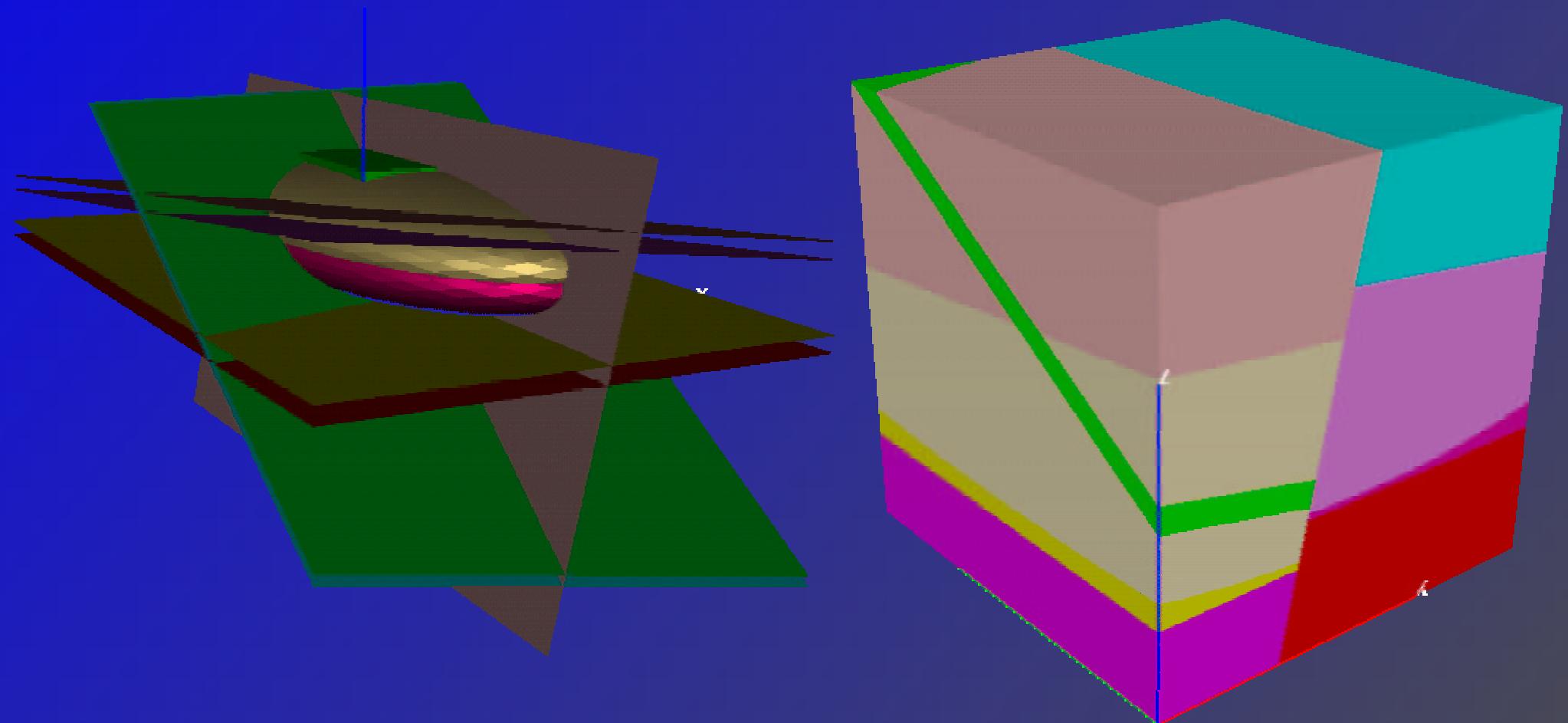


R1 = Volume (lt S5)

R2 = Volume(gt S1 and lt S2 and lt S3  
and gt S4 and gt S5)

# Boolean Region Definition

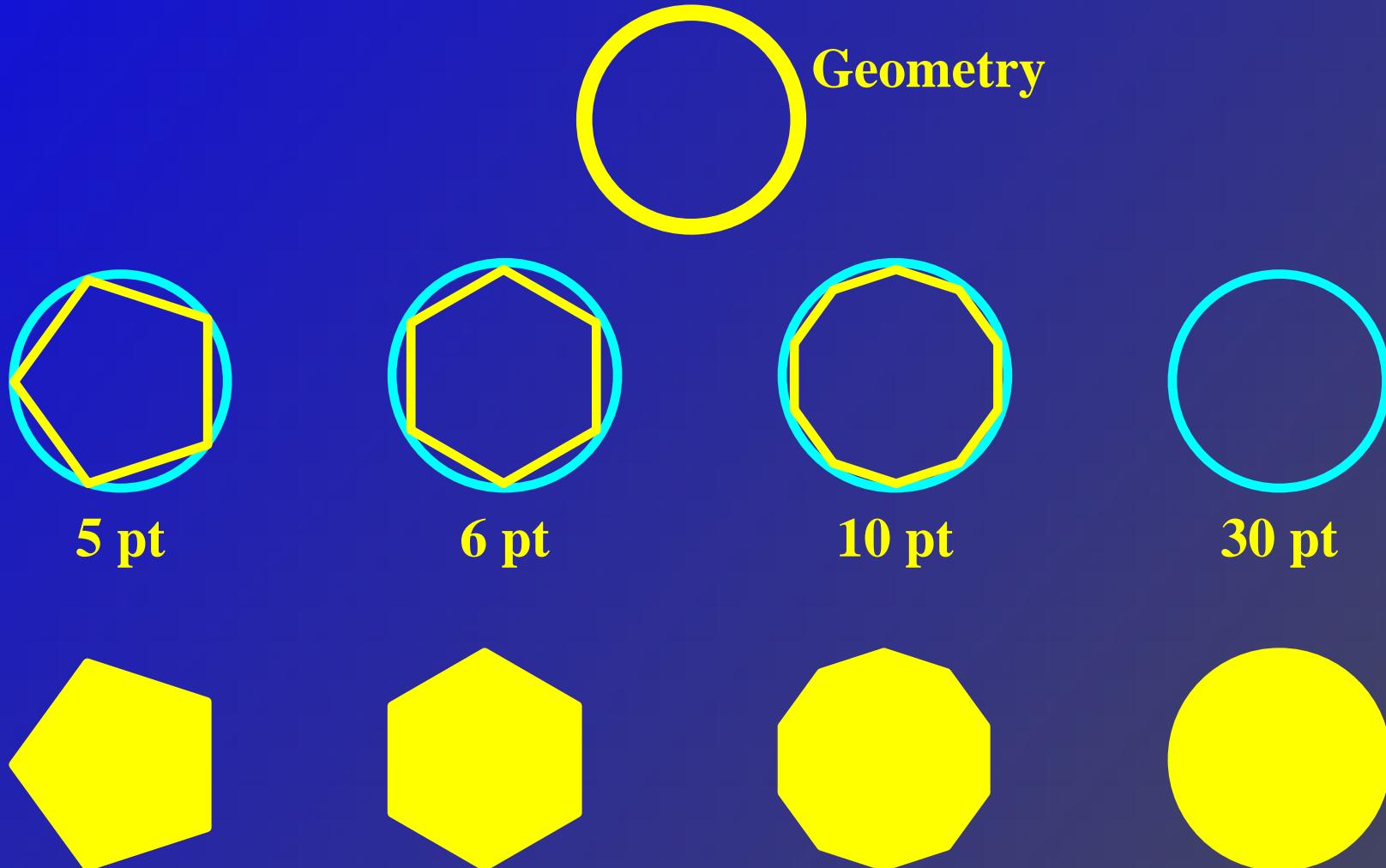
10 Surfaces <-----> 9 Regions



# Point Distribution Queries

## Geometry Definition

- Increasing Mesh Resolution Captures Smaller Features



# The Bottom Line

- ☛ Define Geometry Independent of Computational Mesh
- ☛ Mesh Generation Options are Increased
- ☛ Increased Grid Resolution Results in Increased Geometric Resolution
- ☛ Problem Definition is not Tied to Mesh

# Mesh Generation for Geological Applications

- Geometry is inferred, not designed
- High aspect ratio (100km x 10km)
- Physics needs more resolution than geometry
- Geometry not in CAD format

## Mesh Requirements Are Application Specific

- Hydrology: compatible with conservative discretization schemes
- Shock Physics: Hex Mesh
- Lagrangian/Eularian
- Boundary layers

# LAGriT: Los Alamos Grid Toolkit

## LAGriT User Interface

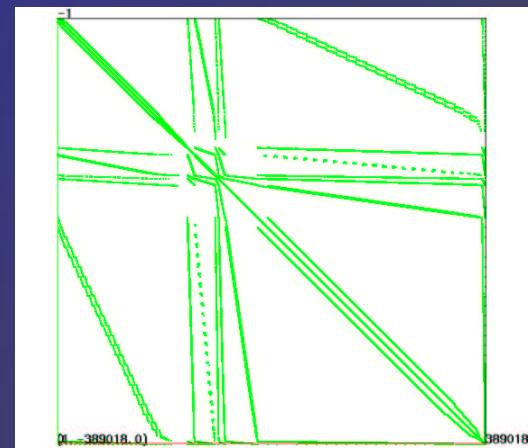
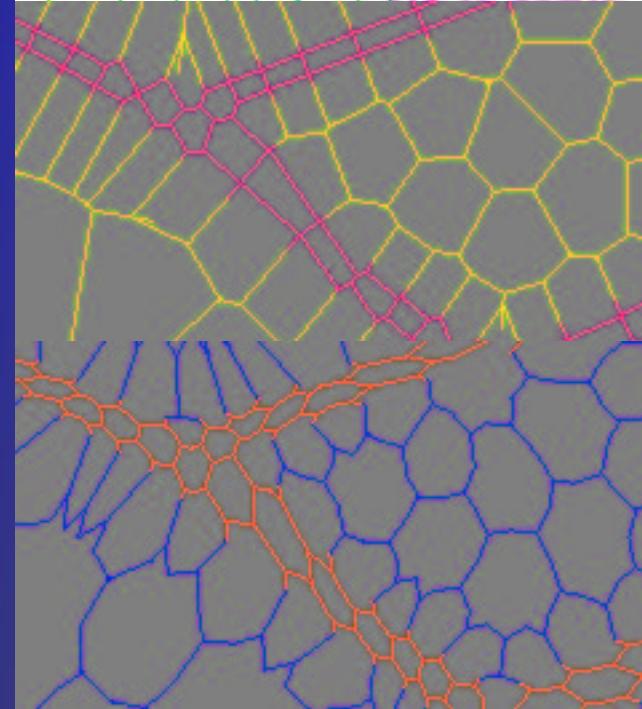
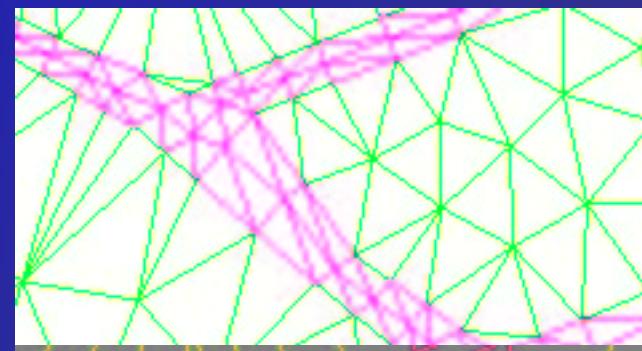
- Command Line
- Batch Control Files
- Call by C and Fortran
- User defined modules
- No GUI

## Access To Mesh Objects

- From C & Fortran
  - `get_information()`, `put_information()`
    - geometry, topology, properties
    - pointers to data structure entities
  - ascii, binary files

# LAGrIT IO

- AVS, GMV, STL, FLOTRAN, CHAD
- Control Volumes
  - Voronoi
  - Median
- Sparse Matrix
  - Area Coefficients
  - Volume Coefficients
  - Incidence Matrix (connectivity)
  - Matrix compression



# LAGriT Geologic Model Input

- Stratamodel
- EarthVision
- GoCad
- ArcInfo, ArcGrid

# LAGiT: Mesh database management

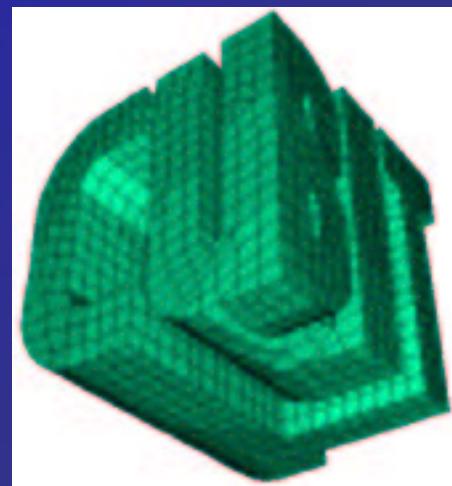
- Topology
  - add/delete nodes
  - topology update (who is connected to whom)
  - node <–> edge <–> face <–> element
- Attributes
  - node, element
  - integer, real
  - scalar, vector, tensor
- Attribute Interpolation
  - linear, log, ln, exp, arctan, arcsin, and, or, min, max, user\_defn
  - user\_defn can provide attribute update for remapping
  - grid to grid interpolation

# Hexahedral Meshing

## LAGriT

- Structured
- Block Structured
- Quadtree Refine
- Octree Refine

CUBIT – Sandia National Laboratory  
[endo.sandia.gov/cubit](http://endo.sandia.gov/cubit))



# LAGrIT

- Available as compiled libraries
- Registration and License procedures
- DEC, HP, LINUX (Absoft), SGI, SUN
- partial source available on request

[www.t12.lanl.gov/home/lagrit](http://www.t12.lanl.gov/home/lagrit)



# LAGriT: Los Alamos Grid Toolbox

## Point Distribution

- xyz, rtp, rtz
- ray shooting
- read/write

## Connectivity

- Delaunay Triangles and Tetrahedra
- Structured (i,j,k)
- Block Structured

## Quality Improvement

- Smoothing
- Refine
- Derefine
- Graph Massage (refine/derefine/smooth)